Understanding the Weapon Focus Effect: The Role of Threat, Unusualness, Exposure Duration, and Scene Complexity

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Abstract

We examined the role of exposure duration and scene complexity on the weapon focus effect (WFE). Memory for the a mock crime was affected more by a weapon than an unusual but nonthreatening object. Threat reduced correct identifications when the event was short but not long; duration of the event did not interact with unusualness. Additionally, we found a WFE for target-absent lineup decisions, but only for the accomplice lineup, not the object-wielding perpetrator's lineup. We discuss the implications of these results for illuminating the mechanisms that elicit the WFE.

Understanding the Weapon Focus Effect: The Role of Threat, Unusualness, Exposure Duration, and Scene Complexity

The weapon focus effect (WFE) refers to the tendency for memory for a perpetrator of a crime to be poorer when the perpetrator held a weapon or an unusual object. The effect has been reliably demonstrated in multiple meta-analyses (Fawcett, Russell, Peace, & Christie, 2013; Kocab & Sporer, 2016; Steblay, 1992). The effect is considered to occur because weapons and unusual objects capture attention, although the precise mechanism through which attention is captured is still unclear—whether via arousal or surprise (see Kocab & Sporer, 2016 for a recent and thorough review of these theories).

One explanation of the WFE is that the threatening nature of a weapon causes arousal (through stress and/or fear). Fear has been shown to cause attentional narrowing whereby attention is devoted to the stimulus evoking the fear (i.e., a central stimulus) to the exclusion of other stimuli in the environment (i.e., peripheral stimuli, Christianson, 1992). There is evidence supporting this view (Hope & Wright, 2007; Hulse & Memon, 2006; Kramer, Buckhout, & Eugenio, 1990) although evidence to the contrary is perhaps more often found (e.g., Cooper, Kennedy, Hervé, & Yuille, 2002; Harada, Hakoda, Kuroki, & Mitsudo, 2015; Shaw & Skolnick, 1999; Van Koppen & Lochun, 1997; Wagstaff et al., 2003) and threat was not a significant moderator in a recent meta-analysis (Fawcett et al., 2013). However, eliciting arousal in the laboratory akin to the level of arousal that would be inspired during a weapon-involved crime would be unethical, therefore effective tests of this hypothesis are challenging (Fawcett, Peace, & Greve, 2017).

The alternative view is that the WFE occurs because of expectancy violations: When a stimulus appears that is unexpected in the context of a scene, attention is drawn to it. That is, the surprising nature of weapons and the processing necessary to resolve that

surprise and make sense of the scene result in poorer memory for persons and events (cf. when a weapon is not involved). Indeed, the WFE has been found with a variety of non-threatening but unusual items (e.g. Hope & Wright, 2007; Mitchell, Livosky, & Mather, 1998; Pickel, 1998). Moreover, threatening objects shown in a context in which they would be expected and therefore not perceived as threatening at the time (e.g., a gun at a gun range) do not elicit a WFE (McRae, Sharps, Power, & Newton, 2014; Pickel, 1999). Importantly, Fawcett et al. (2013) found that unusualness was a significant moderator of the WFE.

A few studies have examined the relative contributions of threat and unusualness. In two experiments Pickel (1998) crossed threat and unusualness and found no effect of threat but a significant effect of unusualness. Likewise, Shaw and Skolnick (1999), using a video mock crime and testing recall of the features of the mock criminal, did not find a difference in the magnitude of the WFE for a weapon (gun) compared to unusual and unexpected objects (stethoscope, space cones). In contrast, Hope and Wright (2007) found evidence that threat has an effect over and above that of unusualness. Participants viewed slides depicting a man entering a convenience store and removing a usual, nonthreatening object (wallet), an unusual, nonthreatening object (a feather duster), or an unusual, threatening object (gun). Performance on another task (detecting digits) was higher in the feather duster condition than the gun condition and both led to poorer performance than the wallet condition. However, the greater effect of the gun over the feather duster extended to memory for the slides only when confidence in the memory questions was taken into account. We contribute to the literature examining the relative effects of threat and unusualness by examining memory for events that involve threatening and/or unusual objects.

Regardless of the role of threat, the WFE is an attentional effect. As a result, we can further our understanding of it by exploring factors that are known to influence attention. Another aim of this research is to examine the role played by two factors known to affect attention: exposure duration and scene complexity.

Exposure Duration

People lose interest in a novel stimulus the longer they are exposed to it, a process which reflects the general cognitive process of habituation (e.g., Bradley, Lang, & Cuthbert, 1993; Johnson, Dziurawiec, Ellis, & Morton, 1991). Fawcett et al. (2013) examined the duration of exposure to a critical object as a potential moderator of the WFE. They found a quadratic relationship such that the magnitude of the WFE on memory for details of the event was smaller when participants were exposed to a perpetrator for 10 seconds or less or for more than 60 seconds compared to when exposure lasted 10 to 60 seconds. Presumably, if witnesses have insufficient time to process a weapon or have enough time to get used to the weapon, the WFE is attenuated.

However, Fawcett et al.'s (2013) conclusions were tentative as their moderation analysis was based on the *reported* exposure durations in the experiments that comprised their meta-analysis, rather than *experimental manipulations* of exposure duration as part of these experiments. For example, most of their short exposures involved slide exposures whereas longer exposures tended to involve videos or live events—a potential alternative moderator (but see Steblay, 1992 for evidence contrary to this possibility).

Few experiments have directly manipulated exposure duration in relation to the WFE. Cutler, Penrod, and Martens (1987) manipulated exposure duration and weapon visibility, as well as a variety of other factors. They showed participants a mock criminal holding a gun or concealing it for 30 or 75 seconds. Although a WFE was found, exposure duration did not affect identification accuracy, nor did it interact with weapon visibility.

However, one explanation for the lack of effect of exposure duration in Cutler et al. is that the WFE effect tends to be stronger for recall than identification (Fawcett et al., 2013; Steblay, 1992) and there is evidence that the WFE for identifications may be negligible (Kocab & Sporer, 2016). Kramer et al. (1990) looked at recall as well as lineup identifications and manipulated exposure duration to an object held by a perpetrator. They showed a meat cleaver or a news magazine for 3, 12, or 18 seconds and the perpetrator's face for 12 or 18 seconds, with simultaneous exposure to both occurring for varying amounts of time. They found a WFE for recall but not identification decisions regardless of exposure except when the weapon was seen only briefly, in which case they found no WFE.

Erickson, Lampinen, and Leding (2014) manipulated whether a weapon appeared before, during, or after exposure to a mock criminal and found evidence that the timing of the view of the weapon versus the perpetrator is important, in contrast to Kramer et al. (1990). Target-present but not target-absent lineup performance was negatively impacted by *simultaneous* presentation of a weapon and the target relative to presentation of a non-weapon and target; there was no WFE for the *before* or *after* conditions.

Recent research has found that exposure duration may interact with weapon presence. Carlson et al. (2016) used very short exposures (3 or 10 seconds) and found a weapon focus effect for the three second exposure but not 10 second exposures for memory for the event overall. When they looked only at questions about the perpetrator, they found the WFE for their 10 second exposures, even when the exposure to the weapon itself was very brief. Thus, the magnitude of the WFE was strongest—extending to memory for the scene and perpetrator—when exposure duration was shortest (3s) but still present when the exposure duration was longer (10s)—but only for memory for the

perpetrator. The current research provides further evidence relevant to the role of exposure duration in relation to the WFE.

Scene Complexity

Research on factors influencing attention has long demonstrated that the more complex a stimulus array is, the more difficult it is to detect a target (Rosenholtz, Li, & Nakano, 2007; Wolfe, 1998). Targets that are salient (i.e., unique within a display) are easier to detect than non-salient or less salient targets (Parkhurst, Law, & Neibur, 2002; Torralba, Oliva, Castelhano, & Henderson, 2006). Relatedly, the more salient a target is, the more quickly it is detected (e.g., Blagrove, Blagrove, & Watson, 2014; Kean & Lambert, 2003). Unusual objects are a type of salient object and research indicates that they are looked at for longer than usual objects (Henderson, Weeks, & Hollingworth, 1999; Loftus & Mackworth, 1978), analogous to findings of attention to weapons (Loftus, Loftus, & Messo, 1987). Furthermore, saliency significantly affects visual search in simple displays but tends to be less predictive of search in complex displays (van Zoest, Van der Stigchel, & Donk, 2017). Thus, it stands to reason that scene complexity may moderate the WFE; however, no research has examined this issue.

Yet, the issue of scene complexity was raised early on as a potential moderator by Shaw and Skolnick (1999). They reasoned that Shaw and Skolnick (1994, as cited in Shaw & Skolnick, 1999) failed to find a WFE because their participants had been exposed to "simple and non-arousing stimulus conditions" (p. 2330). Thus, they predicted that a WFE would arise in a "rich and complex stimulus field" (p. 2330) and indeed, they obtained a WFE using such a mock-crime video. In contrast, Cooper et al. (2002) examined the number of details recalled by victims of sexual assault when the event involved a weapon or not and did not find a WFE—and found a trend in the opposite direction. They concluded that their failure to obtain a WFE may have been due to actual crime scenes

being *more* complex than those approximated in the laboratory. The reasoning provided by Cooper et al. was that the greater number of focal points available to crime victims led them to be less focused on a weapon than in laboratory experiments, a line of reasoning first raised by Steblay (1992). Although a variety of other challenges in field data collection make it difficult to draw strong conclusions from Cooper et al., the WFE has been absent in other analyses of field data as well (Tollestrup, Turtle, & Yuille, 1994; Valentine, Pickering, and Darling, 2003; Yuille & Tollestrup, 1986). It is reasonable to assume that field studies involve a more complex environment than videos of mock crimes used in laboratory studies of the WFE. Thus, field research suggests that scene complexity may be a moderator of the WFE.

Given the extant results pertaining to scene complexity, it may be plausible to predict a quadratic relationship between the WFE and scene complexity, much like for exposure duration. That is, a very low level of complexity (such as used in Shaw & Skolnick, 1994, as cited in Shaw & Skolnick 1999) and a very high level of complexity (such as in the real world) may result in a failure to elicit a WFE while a moderate level of complexity may be conducive to a WFE. The current research explored whether scene complexity interacts with weapon presence in laboratory settings (i.e., the early and midpoints of a quadratic relationship).

The role of scene complexity in the WFE is important to understand because crimes occur in a variety of settings—complex ones filled with many salient and important objects, such a busy bank—and simple ones filled with few salient and important objects—such as a small, local bank where the eyewitness is the only customer. Even if highly complex and arousing crimes do not elicit a WFE, it is worth determining whether crimes which elicit a relatively low level of arousal might be expected to elicit the WFE. As such, understanding the role of scene complexity can contribute to the criminal justice

system's ability to weigh the reliability of eyewitness evidence when a weapon is involved.

The Current Research

We manipulated exposure duration and scene complexity in order to enhance our understanding of how these factors relate to the WFE. In addition, we manipulated threat and unusualness in order to examine their relative effects. We predicted interactions among complexity, duration, and one or both of threat and unusualness. That is, we expected a weaker WFE for long than short events and for simple than complex scenes. We further predicted that threatening objects would have a more detrimental effect on memory than unusual objects.

Pilot Study

We first explored whether duration and complexity would moderate the weapon focus effect in a pilot study. Participants (N = 142) were randomly assigned to conditions in a 2 (Threat: nonthreatening, threatening) x 2 (Unusualness: usual, unusual) x 2 (Duration: short, long) x 2 (Complexity: simple, complex) x 2 (Target presence: present, absent) x 2 (Target: holding object, not holding object) mixed design. The participants watched one video of two teaching assistants in a staff break room discuss an interaction with a student (third-person perspective). We manipulated duration by presenting the video as a 15 or 60 second-long clip, so that we would span the durations found by Fawcett et al. (2013) to moderate the WFE. We manipulated complexity by showing the full video or cropping it tightly to the actors (see supplemental Figure 1). The cross of threat and unusualness was attempted by having one of the actors hold a gun, knife, flamingo, or three-hole punch throughout the video. However, ratings obtained from a different set of participants (N = 24) indicated that the gun, knife, and flamingo did not differ in unusualness but that all three were more unusual than the three-hole punch. As

such, threat and unusualness were considered separately. After viewing the video, participants were asked a series of recall and recognition questions about the event and actors and then viewed lineups for the actors.

We did not find a WFE on any of our measures except target-present identifications of the object-wielding actor (an effect of unusualness)[1]. Instead, our results broadly indicated that when the actor held a threatening object or an unusual object, memory for the video was superior to when the actor held a non-threatening object.[2] Given that our video did not depict a mock crime, it is plausible to conclude that either the lack of realism or the lack of a crime can account for these unexpected results. Thus, in our subsequent experiment, we used a mock-crime filmed from the witness' perspective.

However, these data did provide an impetus for further exploring the moderating effects of duration exposure and scene complexity when we conducted a 2 Threatening x 2 Duration x 2 Complexity ANOVA on the proportion correct responses to our questions about the video. We found a three-way interaction of threat, duration, and complexity, $F(1, 134) = 5.63$, $p = .019$, $\eta_p^2 = .04$. To examine this interaction, we conducted separate two-way ANOVAs for the long and short video conditions. When the video was short, we found a significant main effect of complexity $F(1, 68) = 18.17$, $p < .001$, $d = 0.50$, and a significant interaction of complexity and threat, $F(1, 68) = 4.27$, $p = .009$, $\eta_p^2 = .10$. Follow up analyses on the short condition showed there was a simple main effect of threat in the simple video condition, $F(1, 68) = 7.58$, $p = .008$, $d = 0.34$, but not the complex video condition ($p = .30$). When participants saw short, simple videos, they were more accurate if the actor had been holding a threatening ($M = .61$ [.55, .67]) than a non-threatening object ($M = .49$ [.43, .55]). For long videos, there was a significant effect of

[1] The effect of threat on lineup decision making was not examined because due to a programming error it was confounded with target presence.
[2] A full report of the results of our analyses for the pilot study can be found in the supplemental materials.

complexity only, $F(1, 66) = 4.14$, $p = .046$, $d = 0.25$ (all other ps > .30). For long videos, participants remembered more when they had seen a simple video ($M = .60$ [.55, .64]) than a complex video ($M = .53$ [.48, .58]). The simple effect of complexity when participants viewed long videos was not significant ($p = .17$).

Furthermore, a 2 Unusualness x 2 Duration x 2 Complexity ANOVA on the questions testing memory for the object-wielding actor elicited a significant three-way interaction of duration, complexity, and unusualness, $F(1, 134) = 6.41$, $p = .013$, $\eta_p^2 = .05$ (all other ps ≥ .13). Follow up analyses indicated no significant effect of complexity, unusualness, or their interaction on memory for the actor wielding the object when the video was short (ps > .21). When the video was long, the effect of complexity was significant, $F(1, 66) = 4.99$, $p = .029$, $d = 0.27$, and there was a significant interaction of complexity and unusualness, $F(1, 66) = 9.58$, $p = .003$, $\eta_p^2 = .13$. Simple effects analysis showed that memory for the actor was higher when he held an unusual ($M = .85$ [.75, .95]) than a usual object ($M = .61$ [.47, .75]) in the complex video ($p = .007$) but usualness made no difference in the simple video condition ($p = .12$).

Our pilot study suggested that we should use a more ecologically valid approach to testing the WFE. We reasoned that our threat manipulation may not have had an effect because participants were not highly engaged (the delay between watching the video and answering questions was negligible). For the subsequent study, we filmed a mock-crime (rather a video of another interaction between two people) from the perspective of the witness (i.e., first-person rather than third-person). Nonetheless, our results indicated that the effect of held objects on memory for events is moderated by duration exposure and scene complexity.

Method

Participants

Participants (N = 147) were recruited from a UK university's students and staff as well as from the broader community. The sample was .74 female, ranging in age from 18 to 59 years (M = 23.75, SD = 6.12). Of the sample, .77 identified as British (White) and .23 identified with other categories.

Design

The design was a 4 (Object: gun, knife, flamingo, binder) x 2 (Duration: short, long) x 2 (Complexity: simple, complex) x 2 (Target presence: present, absent) x 2 (Target: holding object, not holding object) mixed design wherein only Target presence and Target were manipulated within-subjects. Object refers to the item with which one of the actors threatened another actor and is described in detail below. Duration refers to the length of the mock crime video which was either short (20-22 s) or long (32-38 s). Scene complexity refers to the number of extraneous objects that appeared in the video such that the complex video included 15 more objects than the simple video. Target presence refers to whether the actor was included or not included in the lineup and Target refers to the actors in the video.

Materials

The experiment was presented using Empirisoft MediaLab (Jarvis, 2011) on a standard desktop computer. Participants listened to the mock-crime video through headphones.

Mock-crime videos. The videos depicted a bank robbery from the perspective of a customer who enters a bank, interacts with a bank teller, sits down to wait, and then witnesses a bank robbery. We edited the original (long) videos to create the short videos. Thus, after 10-12 seconds (short duration condition) or 23-26 seconds (long duration condition), two robbers enter the bank and demand money from the bank teller. The robbers and bank teller were visible for the remainder of the video (9-12 seconds) while a

focal object was visible for about eight seconds in all videos. The videos were edited to ensure that all videos within each duration condition depicted the same sequence of events; however, specific actions sometimes took slightly longer than other times which is why there is variability in the video durations. One of the robbers held the focal object, either a gun, knife, lawn flamingo, or a three-ring binder. Two videos were filmed for each of the focal objects: one using the complex scene and one using the simple scene. For the complex scene the area filmed was filled with stimuli relevant to a small local bank setting. These objects were then removed from the scene to create a simple scene. Figure 1 illustrates some of the differences.

The classification of the focal objects was determined by an independent group of participants (N = 11). These participants were asked to rate how threatening and unusual the pictures of the focal objects were on a 10 point scale where 1 = *Not very threatening/Very usual* and 10 = *Extremely threatening*/*Extremely unusual*. They were also asked to rate how threatening and unusual the items were within the scene on the same scale. We used a repeated measures analysis of variance (RM ANOVA) to examine our manipulations. The gun was rated as the most threatening (M = 9.59 [9.03, 10.00]), followed by the knife (M = 8.86 [7.75, 9.98), followed by the flamingo (M = 2.23 [1.24, 3.22]), and the binder (M = 1.23 [0.88, 1.58]; all pairwise ps < .05). The gun was also rated as the most unusual (M = 8.32 [6.73, 9.90] but did not differ in unusualness from the knife (M = 6.91 [5.08, 8.74]; p = .20)[3] or flamingo (M = 8.86 [7.75, 9.98]; p = .10), which also did not differ from each other (p = .96) The gun, knife, and flamingo were all rated as significantly more unusual than the binder (M = 1.32 [0.97, 1.66]; ps < .001).

[3] We had reasoned that due to television programmes featuring armed robberies that the gun would not be seen as unusual. However, these pilot data clearly indicate otherwise.

Memory questions. Participants answered nine cued recall questions about the scene; those in the complex scene condition then answered an additional six questions. Next, participants were asked eight recognition questions from which they could choose one of four responses; those in the complex scene condition then answered an additional four questions. We posed more questions to our complex than simple scene condition participants because there was no reason to expect participants in the complex scene to preferentially attend to the items present in both scene conditions. One cued recall question and one recognition question asked about the actor holding the focal object.[4]

A subsample of participants (n = 12) were asked to describe the perpetrator who threatened the bank teller (i.e., the one with the focal object) and his accomplice. This subsample was also asked three questions designed to check that they had paid appropriate attention to the mock-crime video. The first was a cued recall question while the second was a recognition question asking what object one of the perpetrators had been holding. Next, these participants were separately asked to rate how threatening and how unusual they found the object held by the perpetrator to be on a 1 to 7 scale where 1 = *Nonthreatening*/*Very usual* and 7 = *Extremely threatening*/*Extremely unusual*. Given the size of the subsample, these data are not examined.

Lineups. We presented lineup members simultaneously in a 3 x 2 array. Only the head of each lineup member was shown. Target-absent and target-present lineups were constructed for the perpetrator with the focal object and his accomplice. Six lineup foils were selected using the match to perpetrator approach from a large database of foils maintained in the lab (Wells, Rydell & Seelau,1993).

[4] One of the recognition questions asked of all participants was about the non-object wielding perpetrator; however, due to a programming error, participants in the complex scene condition were asked a question about the second perpetrator twice (this did not result in the failure to ask any other question).

Target-absent lineups comprised all six foils while the target-present lineups comprised five foils, randomly selected from the six, and the perpetrator. We do not report lineup fairness measures because of the concerns associated with them (Mansour, Beaudry, & Lindsay., 2017). That is, the values produced for a specific lineup can vary considerably as a function of the type of descriptions used and whether a target-present or -absent lineup is shown to the mock-witnesses. Instead, Supplemental Table 2 provides further detail about responses to individual lineups to illustrate the spread of choices around lineup members.

Each participant made two lineup decisions: one about the perpetrator with the focal object and one about the accomplice. Participants always saw one target-present and one target-absent lineup. We counterbalanced which target's lineup was target-present and which was target-absent across the experiment. Participants were always shown the lineup for the perpetrator who had not held the focal object first but for both lineups they were simply asked "Were any of these people in the video?" and told that the lineup would contain one or none of the perpetrators. Fair lineup instructions were provided with each lineup (Malpass & Devine, 1981).

Procedure

Participants were asked to sit at a computer, put on headphones, and follow the instructions on the screen. After the participant clicked a button to indicate they were ready to begin, a single mock-crime video played. Immediately following the video, participants were informed that they were now an eyewitness to a mock crime and were asked to contact the researcher. At this stage the researcher obtained informed consent. Next, participants answered demographic questions, were questioned about the mock crime, and made the two lineup decisions, including rating their confidence in these decisions on the same scale as in Experiment 1. Finally, participants were debriefed and

thanked. Our procedure was in accordance with the ethical standards of the responsible committee on human experimentation.

Measures

We calculated the overall proportion correct responses to the cued recall and recognition questions about the video. Proportion correct responses were calculated first for the questions completed by all participants and then for all the questions answered by a participant (i.e., the calculation differed depending on whether the participant was in the simple or complex scene condition). We also calculated proportion correct for the questions about the object-wielding actor. Target-present lineup decisions were coded as accurate (identifications of the actor) or inaccurate (all other decisions) for each actor. Target-absent lineup decisions were also coded as accurate (rejections of the lineup) or inaccurate (all other decisions) for each actor. Following Erickson et al. (2014), we also coded target-present lineup decision as rejections versus selections; however, these analyses are reported in our supplemental analyses for brevity.

Results

We conducted separate analyses for each of threat and unusualness based on the ratings we had previously obtained from independent participants. For unusualness, we coded participants who saw the crime committed with a gun, knife, or flamingo as unusual and those that saw the crime committed with a binder as usual. We also analysed our results using the mean threat or unusualness rating for each object as the predictor; however, using these continuous values produced the same results as using the dichotomous predictors, therefore these analyses are not reported.

Because a relatively large proportion of our sample (.22) reported their ethnicity as something other than British (White) and our perpetrators were White, we considered whether cross-race effects might influence our results. All analyses were conducted both

with and without our non-White participants; however, no changes in the pattern of means or significant effects was found other than that four effects that were significant became marginally significant (.05 < *p*s < .09) and one marginally significant effect became non-significant (*p* = .50)—presumably reflecting the reduction in power.

All memory questions

Our first set of analyses concerned performance on all of the cued recall and recognition questions asked participants.

Threat. We entered the proportion correct on the cued recall and recognition questions into a 2 Threat x 2 Duration x 2 Complexity ANOVA. We found a main effect of threat, $F(1, 139) = 22.56$, $p < .001$, $d = 0.40$, such that participants remembered less when the perpetrator held a threatening object (*M* = .32, [.29, .35]) compared to a non-threatening object (*M* = .43, [.40, .46]), indicating a WFE. We also found a main effect of complexity, $F(1, 139) = 9.79$, $p = .002$, $d = 0.26$. Participants remembered more about the simple scene (*M* = .41, [.38, .44]) than the complex scene (*M* = .34, [.30, .37]). No other main effects or the interactions were significant (all *p*s > .14). Table 1 reports the relevant estimated marginal means.

Participants who viewed the complex scene were asked more questions than those who watched the simple scene and it is possible that the different metrics are obscuring our findings. Thus, we conducted a second 2 Threat x 2 Duration x 2 Complexity ANOVA on just the questions answered by all participants. The analysis eliminated the effects of complexity (*p* = .58), but the results were otherwise identical to our original analysis.

Unusualness. We next conducted a 2 Unusualness x 2 Duration x 2 Complexity ANOVA on overall proportion correct (see Table 2 for estimated marginal means). Participants remembered more about the scene when they viewed the crime being committed with the usual object, the binder (*M* = .44, [.39, .49]) compared to the other

objects (i.e., the gun, knife, or flamingo; M = .35, [.32, .38]), $F(1, 139) = 11.18$, $p = .001$, $d = 0.27$. In addition, participants remembered more about the video when it was simple (M = .43, [.39, .47]) than when it was complex (M = .36, [.32, .40]), $F(1, 139) = 6.24$, $p = .014$, $d = 0.20$. There were no other significant effects or interactions (ps > .20). We conducted a second ANOVA on the proportion correct responses to questions seen by all participants only. The main effect of complexity became nonsignificant ($p = .78$) but the pattern of results was otherwise unchanged.

Threat versus unusualness. To examine the relative effects of threat and unusualness we next conducted a 3 Object x 2 Duration x 2 Complexity ANOVA on overall proportion correct. Object was coded such that the gun and knife videos comprised the threatening and unusual condition, the flamingo video comprised the nonthreatening and unusual condition, and the binder video provided a nonthreatening and usual condition. We found the significant main effect of complexity described above, $F(1, 135) = 10.70$, $p = .001$, $d = 0.27$, as well as a significant main effect of object, $F(2, 135) = 11.58$, $p < .001$, $\eta_p^2 = .15$. Follow up pairwise comparisons indicated that participants remembered less about the video if it involved the gun or knife (M = .32 [.29, .35]) than the flamingo (M = .42 [.37, .47]; $p = .001$) or binder (M = .44 [.40, .49]; $p < .001$), which did not differ ($p = .49$). Table 3 reports the relevant estimated marginal means. When we analyzed only the questions which were answered by all participants, the effect of complexity was not significant ($p = .39$) but the results were otherwise the same.

Questions about the object-wielding actor

Our next set of analyses concerned the two questions asked about the actor who held the focal object.

Threat. We conducted a 2 Threat x 2 Duration x 2 Complexity ANOVA on the proportion correct responses to questions about the object-wielding actor. The analysis resulted in no significant effects or interactions (all *p*s > .13; see Table 1).

Unusualness. We next conducted a 2 Unusualness x 2 Duration x 2 Complexity ANOVA. This analysis elicited a significant main effect of unusualness on memory for the object-wielding perpetrator, $F(1, 139) = 5.40$, $p = .022$, $d = 0.19$, but no other significant effects or interactions (*p*s > .30).The pattern of means matched that from the overall memory analysis whereby memory was more accurate if the actor wielded a binder (*M* = .54 [.44, .65]) compared to any other object (*M* = .40 [.34, .46]; see also Table 2).

Threat Versus Unusualness. Finally, we conducted a 3 Object x 2 Duration x 2 Complexity ANOVA on memory for the object-wielding actor. A marginal effect of object was found, $F(2, 135) = 2.51$, $p = .085$, $\eta_p^2 = .04$.[5] Participants were significantly more accurate in the binder condition (*M* = .54 [.44, .65]) than the gun/knife condition (*M* = .40 [.33, .47]; *p* = .03); neither the binder condition (*p* = .10) nor the gun/knife condition (*p* = .82) differed significantly from the flamingo condition (*M* = .42 [.31, .52]; see also Table 3).

Lineups

We entered our predictors into a logistic regression model to predict the accuracy of lineup decisions (all main effects entered in step 1, interactions entered using a step-wise forward regression likelihood ratio approach in the second step), with separate analyses for target-present and target-absent lineup decisions. We conducted separate analyses for the object-wielding perpetrator and the accomplice.

[5] We also conducted this analysis with object as entered as a four-level predictor. The analysis produced no significant effects. The effect of object did not approach significance (*p* = .18).

Threat. We first examined threat, duration, and complexity as well as their interactions as predictors.

Target-present Lineup Accuracy. The model for target-present lineup accuracy of the object-wielding actor was significant, $\chi2(4) = 13.10$, $p = .011$, $r_{Nagelkerke}^2 = .22$. In the final model, complexity and duration were not significant (ps > .22); however, threat was, $B = -2.18$, $\chi2(1) = 8.14$, $p = .004$, $OR = .11$, indicating participants were 8.85 times more likely to identify the perpetrator who had held an object if he had held a nonthreatening object (.56) compared to a threatening one (.38; i.e., a WFE). This effect was qualified by a significant interaction of duration and threat, however, $B = 2.73$, $\chi2(1) = 6.80$, $p = .009$, $OR = 15.28$. Follow up z-tests comparing objects separately for the long and short video conditions indicated that when the video was short, correct identifications were more frequent when the video involved a nonthreatening (.65) than a threatening object (.18), $z = 2.99$, $p = .003$. When the video was long, performance did not significantly differ between the nonthreatening (.47) and threatening conditions (.61), $z = 0.80$, $p = .42$. The model for the target-present lineup accuracy for the accomplice was not significant, $\chi2(3) = 2.26$, $p = .52$, $r_{Nagelkerke}^2 = .04$ (all main effects ps > .24). Table 4 illustrates how participants chose from target-present lineups as a function of threat, duration, and complexity.

Target-absent Lineup Accuracy. For target-absent lineup decisions, neither the model for the object-wielding perpetrator, $\chi2(3) = 3.15$, $p = .37$, $r_{Nagelkerke}^2 = .06$ ($p > .11$ for all main effects), nor the model for the accomplice, $\chi2(3) = 5.59$, $p = .13$, $r_{Nagelkerke}^2 = .10$, was significant. However, there was a significant effect of threat on accuracy of target-absent lineup decisions for the accomplice, $B = -1.14$, $\chi2(1) = 4.74$, $p = .029$, $OR = 0.32$, such that the target-absent accomplice lineup was 3.13 times more likely to be

correctly rejected when participants saw a nonthreatening (.47) than a threatening video (.22; all other main effect *p*s > .44; see Table 5).

Unusualness. We next examined the roles of unusualness, duration, and complexity in relation to lineup decisions.

Target-present Lineup Accuracy. Table 6 reports the decisions of our participants when shown target-present lineups. Our final model predicting target-present lineup decision accuracy for the object-wielding perpetrator using unusualness, duration, and complexity as main effects and interactions was significant, $\chi 2(3) = 8.49$, $p = .037$, $r_{\text{Nagelkerke}}^2 = .15$. This model contained main effects only with unusualness the only significant predictor, $B = -1.37$, $\chi 2(1) = 4.92$, $p = .026$, $OR = 0.26$ (*p*s > .23 for the remaining main effects). Participants were 3.92 times more likely to identify the perpetrator holding the focal object when it was usual (.71) than unusual (.38).

The model predicting accuracy identifying the accomplice from target-present lineups was also significant, $\chi 2(3) = 13.26$, $p = .004$, $r_{\text{Nagelkerke}}^2 = .22$, and also contained only the main effects. Again, only the effect of unusualness was significant, $B = -2.12$, $\chi 2(1) = 9.08$, $p = .003$, $OR = 0.12$ (*p*s > .14 for the remaining main effects). Participants were 8.33 times more likely to correctly identify the accomplice if the video involved a binder (.84) rather than a gun, knife, or flamingo (.42).

Target-absent Lineup Accuracy. The target-absent model for the perpetrator holding the focal object was not significant, $\chi 2(3) = 2.52$, $p = .47$, $r_{\text{Nagelkerke}}^2 = .05$ (main effect *p*s > .11). However, the target-absent model for the accomplice was marginally significant, $\chi 2(3) = 6.77$, $p = .080$, $r_{\text{Nagelkerke}}^2 = .12$. This model contained only the main effects and, like for the target-present model, only unusualness was a significant predictor, $B = -1.43$, $\chi 2(1) = 5.95$, $p = .015$, $OR = 0.24$ (*p*s > .50 for the remaining main effects; see

Table 7). Participants were 4.18 times more likely to correctly reject the accomplice's target-absent lineup when the video depicted a binder (.59) than any other object (.25).

Threat Versus Unusualness. Our final analysis examined our three categories of object, duration, complexity, and their interactions as predictors of lineup decision accuracy.[6]

Target-present Lineup Accuracy. The final model for target-present lineups for the object-wielding perpetrator was significant, $\chi 2(6) = 17.26$, $p = .008$, $r_{Nagelkerke}^2 = .28$. We found that object was a significant predictor, $\chi 2(2) = 8.48$, $p = .014$. We used Helmert contrasts to explore this effect. Correct identifications were 6.40 times more likely if the actor held a binder (.71) than a flamingo (.40) or a gun/knife (.38), $B = 1.86$, $\chi 2(1) = 3.88$, $p = .049$, and 5.62 times more likely to make a correct identification if the actor held a flamingo compared to a gun/knife, $B = 1.72$, $\chi 2(1) = 3.87$, $p = .049$[7]. Neither duration ($p = .83$) nor complexity ($p = .30$) were significant predictors.

There was one significant interaction included in this model, that of duration and object, $\chi 2(2) = 7.64$, $p = .022$. The Helmert contrasts indicated that duration did not influence the presence of the WFE (i.e., the comparison between the binder video group and the other three groups; $p = .61$), however, duration did influence the difference between the gun/knife and flamingo groups, $B = -3.66$, $\chi 2(1) = 6.03$, $p = .014$, $OR = 0.03$. Follow up z-tests comparing objects separately for the long and short videos indicated that when the video was short, correct identifications were more frequent when the video involved a flamingo (.56) than a gun or knife (.18), $z = 2.11$, $p = .034$. When the video was long, correct identifications were marginally less likely when the video involved a flamingo (.17) than a gun or knife (.61), $z = 1.87$, $p = .061$.

[6] The results did not differ if object was entered with four versus three levels.
[7] The effect of a flamingo vs a gun/knife is qualified by a significant interaction; therefore should be interpreted with caution.

The final model for the target-present lineup for the accomplice was significant, $\chi2(4) = 14.74$, $p = .005$, $r_{Nagelkerke}^2 = .24$. For this lineup, there was only a significant effect of object, $\chi2(1) = 10.30$, $p = .006$. Helmert contrasts indicated a WFE: the accomplice was 9.50 times more likely to be identified when the video involved a binder (.84) than any other object (.42), $B = 2.25$, $\chi2(1) = 9.87$, $p = .002$, but there was no significant difference in likelihood of identification for the gun/knife condition (.47) compared to the flamingo condition (.32; $p = .23$). Table 8 reports the counts for all target-present lineup decisions as a function of object, duration, and complexity.

Target-absent Lineup Accuracy. The final model for the target-absent lineup for the object-wielding perpetrator was not significant, $\chi2(4) = 3.57$, $p = .47$, $r_{Nagelkerke}^2 = .06$, nor were any of the main effects (ps > .11). Likewise, the model for the target-absent lineup for the accomplice was not significant, $\chi2(4) = 7.52$, $p = .11$, $r_{Nagelkerke}^2 = .14$, although object was a significant predictor within this model, $\chi2(2) = 6.56$, $p = .038$. Participants were 3.71 times less likely to make correct rejections when the video included a gun, knife, or flamingo (.25), than when it included a binder (.59), $B = 1.31$, $\chi2(1) = 4.78$, $p = .029$ ($p > .47$ for all other main effects; see Table 9).

Discussion

In this experiment, we found the typical effects of threat and unusualness on memory for a crime: memory was better when the object held by the perpetrator was nonthreatening versus threatening and when the object was usual versus unusual. Interestingly, our unusual, nonthreatening object (flamingo) had a similar influence on memory for the scene as our usual, nonthreatening object (binder). Although a binder is not unusual in the context of a bank, using a binder to threaten a bank teller is unusual and therefore perhaps memory in this condition was reduced compared to what we would have found if we had presented a bank robbery involving no object. However, when we look at

our results for identification, we see that the odds of a correct identification of the object-wielding perpetrator were significantly higher in the binder condition than the flamingo or gun/knife conditions. These results are relevant to Fawcett et al.'s (2013) call for research on functional novelty (i.e., a familiar object used in a novel way). That is, the binder was used in a functionally novel way, yet clearly did not have the same impact on memory as the unusual or threatening objects. Although we did not include a no object condition and therefore could not test functional novelty directly, our results suggest that if functional novelty does elicit the WFE, it does not elicit as strong a WFE as threatening objects but may elicit as strong a WFE as unusual, nonthreatening objects.

A goal of this research was to examine two potential moderators of the WFE, exposure duration and scene complexity. We expected that these factors would interact with the WFE, and while we did find some interactions, they were not always ones we had predicted. In the pilot study we found that threat helped participants remember short, simple videos while unusualness helped participants remember the actor holding the focal object in long, complex videos. We concluded that because of the mundane nature of the video shown, perhaps the threatening and unusual objects helped draw participants' attention to the video, which enhanced encoding. The lack of a WFE prevented us from evaluating our hypotheses with regard to duration and complexity but provided insight into the role of weapons and unusual objects with regard to memory.

We had expected that longer durations and complex scenes would reduce the magnitude of the WFE compared to short durations and simple scenes. We found no evidence of interactions between threat/unusualness and exposure duration or scene complexity on recall/recognition for the video. In contrast, we found a significant interaction of exposure duration and threat as well as with the object held on the ability of our participants to identify the object-wielding perpetrator. The interaction between

duration and threat was consistent with our predictions whereby the magnitude of the WFE was larger when the video was short than long. That is, correct identifications of the object-wielding perpetrator were significantly reduced when the perpetrator held a weapon (compared to a non-weapon) when the mock crime video was short but this effect disappeared when the video was long.

However, the pattern of results was less clear when we examined the relative effects of threat and unusualness. Having more time for encoding did not mitigate the damaging effect of a gun/knife compared to a binder on identification accuracy—although perhaps this reflects the lower power of not including the flamingo condition cases. However, the relationship between the gun/knife and the flamingo conditions varied as a function of whether the time to encode the scene before the crime began was long or short. That is, when the participants had only 10 to 12 seconds to view the video before the crime, performance was better if the perpetrator held a flamingo than a gun or knife. On the other hand, when participants had 23 to 26 seconds to view the video before the crime, performance was better if the perpetrator held a knife or gun than a flamingo. How can we make sense of this unusual pattern of results?

Participants likely used the time prior to the perpetrators entering the bank in order to encode the information in the scene. Perhaps the surprising occurrence of a robbery disrupted rehearsal and consolidation of that information more when the video was short compared to long, causing them to take longer to finish. When the robbery incorporated a surprising but non-threatening object, perhaps the disruption was shorter-lived than when the object was surprising and threatening. Thus, participants who saw the flamingo video may have recovered from their surprise more quickly than participants who saw the gun or knife video, and thus began encoding the perpetrators more quickly. This would explain why we found more correct identifications of the object-wielding perpetrator in the

flamingo compared to the gun/knife condition when the video was short. Certainly such an interpretation is consistent with recent work demonstrating that weapons reduce functional field of view (Harada et al., 2015) and bias attentional priorities (Biggs, Brockmole, & Witt, 2013).

When opportunity to encode the environment prior to the crime occurring was long, perhaps participants were further along in their rehearsal and consolidation of these details and therefore the surprise was less disruptive. This might explain why there was no advantage for the flamingo condition compared to the gun/knife condition when the video was long, but not why there was an advantage for the gun/knife condition relative to the flamingo condition when the video was short. Perhaps the participant's perception of the importance of attending can explain why in the short video condition seeing a gun or knife resulted in better identification performance than seeing a flamingo.

Prior research indicates that the seriousness of a crime influences identification accuracy such that identification accuracy is higher for more serious crimes (Lieppe, Wells, & Ostrom, 1978). Presumably the object being used to threaten the bank teller signalled the seriousness of the crime and thus, when participants had few resources available for encoding (i.e., the video was short vs. long), they attended more carefully to the object-wielding perpetrator when he held a gun/knife than a flamingo. Thus, a combination of the availability of cognitive resources and increased motivation to remember the perpetrator may have allowed participants to overcome the surprise of seeing a crime which disrupted performance in the gun/knife condition when the video was short. This explanation seems somewhat tenuous so we would argue that further exploration of the interaction between exposure duration and the WFE is merited.

We found the WFE for both target-present lineups and one of the target-absent lineups. The WFE on target-absent lineups only occurred for the accomplice lineup. For

the target-absent accomplice lineup, all three of the regression models tested were not significant overall (i.e., models containing the main effects of duration, complexity and threat/unusualness/object) but object was a significant predictor of correct rejections in all three cases. Very little research has explored the WFE with regard to target-absent lineups and the current research contributes to the body of literature indicating that such effects can sometimes occur (see also Carlson, Dias, Weatherford, & Carlson, 2017; Erickson et al., 2014). Our research indicates that when a crime involves a weapon or an unusual object (vs. a usual, non-weapon object), eyewitnesses are more willing to choose an innocent person from a lineup—perhaps reflecting a difference in motivation as a function of crime seriousness. In addition, this research demonstrates that the WFE can extend to memory for people not holding weapons or unusual objects but who are also involved in the crime.

We found evidence in this experiment that threat has an effect over and above that of unusualness for both memory for the video and identification of perpetrators. These results extend the tentative conclusion of Hope and Wright (2007) about the relative effects of threat and unusualness on memory for crimes, as they found a greater effect of threat only on performance on a secondary task. One possible reason that we found this effect on memory is the nature of the weapon used. In this experiment we used a large airsoft rifle, rather than a handgun, which is more commonly used in this type or research and which is smaller. A larger object may elicit longer inspection because of the additional details available for encoding or elicit a stronger arousal response because it may be perceived as capable of more harm. We ensured that the usual object, the binder, was similar in size to the gun; however a binder arguably has fewer details available for encoding than a gun. Either explanation is plausible for the relatively large WFE we found. Importantly, the size of the gun was purposely very similar to the size of the flamingo and binder; therefore

size cannot account for the difference we found between the flamingo and gun condition for identifications. Our actor wielded the weapon as well as the flamingo in a highly threatening manner; however, it is clear that the potential for harm is much higher in the weapon condition than the flamingo condition and that the effect of threatening actions with a flamingo may be interpreted comically. Thus, our interpretation is that a highly threatening stimulus can produce a stronger WFE than a highly unusual one.

Memory for the scene and perpetrator details was relatively low overall, with participants on average performing below 50% accuracy. This is not surprising as the majority of questions focused on details likely to be considered peripheral—items that were present in the room (see our Supplemental Materials for the specific questions asked). Only a small proportion of our recall and recognition questions concerned the key central information in the scene—the perpetrators (3 out of 14). Nonetheless, when our actor wielded a threatening and/or unusual object, memory for both these types of details was reduced. The WFE on identification accuracy is generally smaller than on recall/recognition (Fawcett et al., 2013) so it is interesting that the interactions we found with the WFE were found only for identifications.

An interesting provisional finding from this research comes from the synthesis of the pilot study and the main experiment. In the former, which was from the third-person perspective and depicted a mundane conversation, the presence of a weapon or unusual object led to an improvement in memory for the video. In contrast, the main experiment, which was filmed from a first-person perspective and which depicted a crime, resulted in a strong WFE. This pattern suggests that in considering the validity of results from lab-based research compared to field experiments on the WFE, the nature of the video itself is quite important. Particularly given the increasingly graphic levels of violence depicted on television and in movies, it may be that a third-person perspective eventually stops

producing a WFE at all. In retrospect, we should have collected ratings of arousal from our participants when watching the videos in both our pilot study and the main experiment in order to better inform the literature on this issue.

Some limitations are worth noting. First, our manipulations of duration exposure focused on the amount of time available to encode the event *when the perpetrators were not present*. We know little about the role of duration but Fawcett et al.'s (2013) meta-analysis focused on the time available to encode the perpetrator's themselves. As such, perhaps it is not surprising that we did not find all of the predicted interactions of the WFE and duration. Nonetheless, as research has not clearly pinned down whether the WFE works through limiting encoding or disrupting storage or retrieval, we still feel there is considerable value to our manipulation.

Second, our scene complexity manipulation may not have been powerful enough to elicit the expected interaction. In our pilot study we found an interaction between the WFE and scene complexity when we manipulated scene complexity by showing the room in which the actors were conversing (complex scene) or cropping the video tightly to the actors to prevent participants from viewing the room (simple scene). However, we felt this manipulation was quite artificial and so for our main experiment manipulated complexity in terms of the number of objects present in the scene with the complex condition containing 15 more items than the simple one. Although memory for the complex condition was poorer than for the simple condition, it is plausible that the complexity we added was insufficient to draw attention away from a mock crime. Future research should consider more heavy-handed manipulations of scene complexity—perhaps in the form of additional actors or movement.

Third, we did not fully cross our manipulations of unusualness and threat, which would have been preferable for clearly discerning the differential role each contributes to

the WFE. At the beginning of this project we wondered whether the typicality of a bank robbery being conducted with a gun would actually mean that we would not find a WFE with the gun whereas the unusualness of the knife as a weapon in a bank robbery would elicit a WFE. In fact, perceptions of the threat and unusualness of the knife and gun in the scene were essentially the same. Thus, our results suggest that indeed threat provides a separate or additional (to unusualness) mechanism by which the WFE occurs.

In conclusion, this research contributes to our understanding of the WFE in a variety of ways. First, we found evidence that threat has an effect over and above that produced by the presence of an unusual object. We also added to the very small literature exploring whether the WFE occurs when witnesses view target-absent lineups—and found that it does. Moreover, we demonstrated that the WFE can occur for identifications of an accomplice to a crime who is not holding a weapon. Finally, we found that the amount of time available to encode a scene prior to and following the witnessing of a weapon-involved crime influences the nature of the WFE for identification but not recall or recognition questions about the event and the perpetrators. More work is needed to explore the effect of exposure duration and scene complexity on the weapon focus effect and we encourage researchers to examine these effects both for threatening and unusual objects on both target-present and -absent lineups.

References

Biggs, A. T., Brockmole, J. R., & Witt, J. K. (2013). Armed and attentive: Holding a weapon can bias attentional priorities in scene viewing. *Attention, Perception, & Psychophysics, 75*, 1715-1724. doi: 10.3758/s13414-013-0538-6

Blagrove, E., & Watson, D. G. (2014). Ignoring real faces: Effects of valence, threat, and salience. *Attention, Perception, & Psychophysics*, *76*, 725-745. doi: 10.3758/s13414-013-0572-4

Bradley, M. M., Lang, P. J., & Cuthbert, B. N. (1993). Emotion, novelty, and the startle reflex: habituation in humans. *Behavioral Neuroscience*, *107*, 970-980. doi: 10.1037/0735-7044.107.6.970

Carlson, C. A., Dias, J. L., Weatherford, D. R., & Carlson, M. A. (2017). An investigation of the weapon focus effect and the confidence–accuracy relationship for eyewitness identification. *Journal of Applied Research in Memory and Cognition*, *6*, 82-92. doi: 10.1016/j.jarmac.2016.04.001

Carlson, C. A., Young, D. F., Weatherford, D. R., Carlson, M. A., Bednarz, J. E., & Jones, A. R. (2016). The influence of perpetrator exposure time and weapon presence/timing on eyewitness confidence and accuracy. *Applied Cognitive Psychology*, *30*, 898-910. doi: 10.1002/acp.3275

Christianson, S. Å. (1992). Emotional stress and eyewitness memory: a critical review. *Psychological Bulletin*, *112*, 284-309. doi: 10.1037/0033-2909.112.2.284

Cooper, B. S., Kennedy, M. A., Hervé, H. F., & Yuille, J. C. (2002). Weapon focus in sexual assault memories of prostitutes. *International Journal of Law and Psychiatry, 25*, 181-191. doi:10.1016/S0160-2527(01)00107-8

Cutler, B. L., Penrod, S. D., & Martens, T. K. (1987). The reliability of eyewitness identification: The role of system and estimator variables. *Law and Human Behavior, 11*, 233-258. doi:10.1007/BF01044644

Erickson, W. B., Lampinen, J. M., & Leding, J. K. (2014). The weapon focus effect in target-present and target-absent line-ups: The roles of threat, novelty, and timing. *Applied Cognitive Psychology*, *28*, 349-359. doi: 10.1002/acp.3005

Fawcett, J.M., Peace, K.A. & Greve, A. (2016). Looking down the barrel of a gun: What do we know about the weapon focus effect?. *Journal of Applied Research in Memory and Cognition, 5*, 257-263. doi: 10.1016/j.jarmac.2016.07.005

Fawcett, J. M., Russell, E. J., Peace, K. A., & Christie, J. (2013). Of guns and geese: A meta-analytic review of the 'weapon focus' literature. *Psychology, Crime & Law, 19,* 1-32. doi:10.1080/1068316X.2011.599325

Harada, Y., Hakoda, Y., Kuroki, D., & Mitsudo, H. (2015). The presence of a weapon shrinks the functional field of view. *Applied Cognitive Psychology, 29,* 592-599. doi: 10.1002/acp.3143

Henderson, J. M., Weeks Jr, P. A., & Hollingworth, A. (1999). The effects of semantic consistency on eye movements during complex scene viewing. *Journal of Experimental Psychology: Human Perception and Performance, 25*, 210-228. doi:10.1037/0096-1523.25.1.210

Hope, L., & Wright, D. (2007). Beyond unusual? Examining the role of attention in the weapon focus effect. *Applied Cognitive Psychology, 21*, 951-961. doi: 10.1002/acp.1307

Hulse, L. M., & Memon, A. (2006). Fatal impact? The effects of emotional arousal and weapon presence on police officers' memories for a simulated crime. *Legal and Criminological Psychology, 11*, 313-325. doi: 10.1348/135532505X58062

Jarvis, B. G. (2011). MediaLab [Computer Software]. New York, NY: Empirisoft Corporation.

Johnson, M. H., Dziurawiec, S., Ellis, H., & Morton, J. (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition, 40,* 1-19. doi: 10.1016/0010-0277(91)90045-6

Kean, M., & Lambert, A. (2003). The influence of a salience distinction between bilateral cues on the latency of target-detection saccades. *British Journal of Psychology, 94,* 373-388. doi: 10.1348/000712603767876280

Kocab, K., & Sporer, S. L. (2016). The weapon focus effect for person identifications and descriptions: A meta-analysis. In M. K. Miller, B. H. Bornstein, M. K. Miller (Ed) & B. H. Bornstein (Ed) (Eds.), (pp. 71-117). Cham, Switzerland: Springer International Publishing. doi:10.1007/978-3-319-29406-3_3

Kramer, T. H., Buckhout, R., & Eugenio, P. (1990). Weapon focus, arousal, and eyewitness memory: Attention must be paid. *Law and Human Behavior, 14,* 167-184. doi:10.1007/BF01062971

Leippe, M. R., Wells, G. L., & Ostrom, T. M. (1978). Crime seriousness as a determinant of accuracy in eyewitness identification. *Journal of Applied Psychology, 63,* 345-351. doi: 10.1037/0021-9010.63.3.345

Loftus, E. F., Loftus, G. R., & Messo, J. (1987). Some facts about" weapon focus". *Law and Human Behavior, 11,* 55-62. doi: 10.1007/BF01044839

Loftus, G. R., & Mackworth, N. H. (1978). Cognitive determinants of fixation location during picture viewing. *Journal of Experimental Psychology: Human Perception and Performance, 4,* 565-572. doi:10.1037/0096-1523.4.4.565

Malpass, R. S., & Devine, P. G. (1981). Eyewitness identification: Lineup instructions and the absence of the offender. *Journal of Applied Psychology, 66,* 482-489. doi:10.1037/0021-9010.66.4.482

Mansour, J. K., Beaudry, J. L., Kalmet, N., Bertrand, M. I., & Lindsay, R. C. L. (2017). Evaluating lineup fairness: Variations across methods and measures. *Law and Human Behavior, 41,* 103-115. doi: 10.1037/lhb0000203

McRae, K., Sharps, M. J., Power, J., & Newton, A. (2014). Eyewitness memory for typical and atypical weapons in cognitive context. *Journal of Investigative Psychology and Offender Profiling, 11*, 179-189. doi: 10.1002/jip.1410

Mitchell, K. J., Livosky, M., & Mather, M. (1998). The weapon focus effect revisited: The role of novelty. *Legal and Criminological Psychology, 3*, 287-303. doi: 10.1111/j.2044-8333.1998.tb00367.x

Parkhurst, D., Law, K., & Niebur, E. (2002). Modeling the role of salience in the allocation of overt visual attention. *Vision Research, 42*, 107-123. doi: 10.1016/S0042-6989(01)00250-4

Pickel, K. L. (1998). Unusualness and threat as possible causes of" weapon focus". *Memory, 6*, 277-295. doi: 10.1080/741942361

Pickel, K. L. (1999). The influence of context on the" weapon focus" effect. *Law and Human Behavior, 23*, 299-311. doi: 10.1023/A:1022356431375

Rosenholtz, R., Li, Y., & Nakano, L. (2007). Measuring visual clutter. *Journal of vision, 7*, 17-17. doi:10.1167/7.2.17

Shaw, J. I., & Skolnick, P. (1999). Weapon focus and gender differences in eyewitness accuracy: Arousal versus salience. *Journal of Applied Social Psychology, 29,* 2328-2341.doi: 10.1111/j.1559-1816.1999.tb00113.x

Steblay, N. M. (1992). A meta-analytic review of the weapon focus effect. *Law and Human Behavior, 16*, 413-424. doi:10.1007/BF02352267

Tollestrup, P.A., Turtle, J.W ., & Yuille, J.C. (1994) Actual victim s and witnesses to robbery and fraud: An archival analysis. In D.F. Ross, J.D . R ead, & M .P. Toglia (Eds.), *Adult eyewitness testimony: Current trends and developments* (pp. 144-160). Cambridge: Cambridge University Press.

Torralba, A., Oliva, A., Castelhano, M. S., & Henderson, J. M. (2006). Contextual guidance of eye movements and attention in real-world scenes: the role of global features in object search. *Psychological review, 113*, 766-786. doi: 10.1037/0033-295X.113.4.766

Valentine, T., Pickering, A., & Darling, D. (2003). Characteristics of eyewitness identification that predict the outcome of real lineups. *Applied Cognitive Psychology, 17.* doi: 10.1002/acp.939

Van Koppen, P. J., & Lochun, S. K. (1997). Portraying perpetrators: The validity of offender descriptions by witnesses. *Law and Human Behavior, 21*, 661-685. doi: 10.1023/A:1024812831576

van Zoest, W., Van der Stigchel, S., & Donk, M. (2017). Conditional control in visual selection. *Attention, Perception, & Psychophysics, 79*, 1555-1572. doi: 10.3758/s13414-017-1352-3

Wagstaff, G. F., MacVeigh, J., Boston, R., Scott, L., Brunas-Wagstaff, J., & Cole, J. (2003). Can laboratory findings on eyewitness testimony be generalized to the real world? An archival analysis of the influence of violence, weapon presence, and age on eyewitness accuracy. *The Journal of Psychology, 137*, 17-28. doi: 10.1080/00223980309600596

Wells, G. L., Rydell, S. M., & Seelau, E. P. (1993). The selection of distractors for eyewitness lineups. *Journal of Applied Psychology, 78*, 835-844. doi:10.1037/0021-9010.78.5.835

Wolfe, J. (1998). Attention. In H. Pashler (Ed.), *Visual search* (pp. 13-74). University College London Press, London UK.

Yuille, J. C., & Cutshall, J. L. (1986). A case study of eyewitness memory of a crime. *Journal of Applied Psychology, 71*, 291-301. doi: 10.1037/0021-9010.71.2.291

Table 1

Mean Correct and 95% Confidence Intervals for the Estimated Marginal Means for All Question or Just Questions About the Object-wielding Actor as a Function of Duration, Complexity, and Threat

.	Long Duration								
	Simple			Complex			Overall		
	Threat	Nonthreatening	Overall	Threat	Nonthreatening	Overall	Threat	Nonthreatening	Overall
Combined	.35 [.29 - .41]	.50 [.43 - .57]	.42 [.38 - .47]	.34 [.27 - .41]	.38 [.32 - .44]	.36 [.31 - .41]	.34 [.30 - .39]	.44 [.40 - .49]	.39 [.36 - .42]
Object Wielder	.34 [.21 - .48]	.50 [.35 - .65]	.42 [.32 - .52]	.47 [.33 - .62]	.47 [.33 - .62]	.47 [.36 - .58]	.41 [.30 - .51]	.49 [.38 - .59]	.45 [.37 - .52]
	Short Duration								
	Simple			Complex			Overall		
	Threat	Nonthreatening	Overall	Threat	Nonthreatening	Overall	Threat	Nonthreatening	Overall
Combined	.33 [.26 - .39]	.47 [.40 - .53]	.40 [.35 - .44]	.26 [.20 - .32]	.37 [.30 - .44]	.32 [.27 - .36]	.30 [.25 - .34]	.42 [.37 - .47]	.36 [.32 - .39]
Object Wielder	.48 [.34 - .62]	.47 [.33 - .62]	.47 [.37 - .57]	.32 [.17 - .46]	.47 [.31 - .62]	.39 [.29 - .50]	.40 [.30 - .50]	.47 [.36 - .58]	.43 [.36 - .51]
	Overall								
	Simple			Complex			Overall		
	Threat	Nonthreatening	Overall	Threat	Nonthreatening	Overall	Threat	Nonthreatening	Overall
Combined	.34 [.30 - .38]	.48 [.44 - .53]	.41 [.38 - .44]	.30 [.25 - .35]	.38 [.33 - .42]	.34 [.30 - .37]	.32 [.29 - .35]	.43 [.40 - .46]	.37 [.35 – .40]
Object Wielder	.41 [.31 - .51]	.49 [.38 - .59]	.45 [.38 - .52]	.39 [.29 - .50]	.47 [.36 - .58]	.43 [.36 - .51]	.40 [.33 - .47]	.48 [.40 - .55]	.44 [.39 - .49]

Table 2

Mean Correct and 95% Confidence Intervals for the Estimated Marginal Means for All Question or Just Questions About the Object-wielding Actor as a Function of Duration, Complexity, and Unusualness

	Long Duration								
	Simple			Complex			Overall		
	Usual	Unusual	Overall	Usual	Unusual	Overall	Usual	Unusual	Overall
Combined	.50 [.40 - .59]	.39 [.36-.51]	.44 [.39 - .50]	.43 [.33 - .53]	.34 [.28 - .40]	.38 [.33 - .44]	.46 [.39 - .53]	.36 [.32 - .40]	.41 [.37 - .45]
Object Wielder	.55 [.35 - .75]	.37 [.25 - .48]	.46 [.34 - .57]	.56 [.34 - .78]	.44 [.32 - .56]	.50 [.38 - .63]	.56 [.41 - .70]	.40 [.32 - .49]	.48 [.40 - .56]
	Short Duration								
	Simple			Complex			Overall		
	Usual	Unusual	Overall	Usual	Unusual	Overall	Usual	Unusual	Overall
Combined	.46 [.37 - .56]	.38 [.32 - .43]	.42 [.36 - .48]	.38 [.28 - .48]	.29 [.23 - .34]	.33 [.28 - .39]	.42 [.35 - .49]	.33 [.29 - .37]	.38 [34 - .42]
Object Wielder	.56 [.35 - .76]	.45 [.34 - .56]	.50 [.38 - .62]	.50 [.29 - .71]	.35 [.22 - .47]	.42 [.30 - .54]	.53 [.38 - .67]	.40 [.32 - .48]	.46 [.38 - .55]
	Overall								
	Simple			Complex			Overall		
	Usual	Unusual	Overall	Usual	Unusual	Overall	Usual	Unusual	Overall
Combined	.48 [.41 - .55]	.38 [.34 - .42]	.43 [.39 - .47]	.41 [.33 - .48]	.31 [.27 - .35]	.36 [.32 - .40]	.44 [.39 - .49]	.35 [.32 - .38]	.40 [.37 - .42]
Object Wielder	.55 [.41 - .70]	.41 [.31 - .48]	.48 [.40 - .56]	.53 [.38 - .68]	.40 [.31 - .48]	.46 [.38 - .55]	.54 [.44 - .65]	.40 [.34 - .46]	.47 [.41 - .53]

Table 3

Mean Correct and 95% Confidence Intervals for the Estimated Marginal Means for All Question or Just Questions About the Object-wielding Actor as a Function of Duration, Complexity, and Object

	Long Duration											
	Simple				Complex				Overall			
	Binder	Flamingo	Gun/Knife	Overall	Binder	Flamingo	Gun/Knife	Overall	Binder	Flamingo	Gun/Knife	Overall
Combined	.50 [.41 - .59]	.50 [.39 - .61]	.35 [.29 - .41]	.45 [.40-.50]	.43 [.33 - .53]	.34 [.26 - .43]	.34 [.27 - .41]	.37 [.32-.42]	.46 [.40 - .53]	.42 [.35 - .49]	.34 [.30 - .39]	.41 [.37-44]
Object Wielder	.55 [.35 - .75]	.43 [.19 - .66]	.34 [.21 - .48]	.44 [.33-.55]	.56 [.34 - .78]	.41 [.22 - .60]	.47 [.31 - .62]	.48 [.37-.59]	.56 [.41 - .70]	.42 [.27 - .57]	.41 [.30 - .51]	.46 [.38-.54]
	Short Duration											
	Simple				Complex				Overall			
	Binder	Flamingo	Gun/Knife	Overall	Binder	Flamingo	Gun/Knife	Overall	Binder	Flamingo	Gun/Knife	Overall
Combined	.46 [.37 - .56]	.47 [.38 - .56]	.33 [.26 - .39]	.42 [.37-.47]	.38 [.29 - .48]	.36 [.25 - .47]	.26 [.20 - .33]	.33 [.28-.39]	.42 [.36 - .49]	.42 [.35 - .49]	.30 [25 - .34]	.38 [.34-.41]
Object Wielder	.56 [.35 - .76]	.40 [.20 - .60]	.48 [.34 - .62]	.48 [.37-.58]	.50 [.29 - .71]	.43 [.19 - .66]	.32 [.17 - .46]	.42 [.30-.53]	.53 [.38 - .68]	.41 [.26 - .57]	.40 [.30 - .50]	.45 [.37-.52]
	Overall											
	Simple				Complex				Overall			
	Binder	Flamingo	Gun/Knife	Overall	Binder	Flamingo	Gun/Knife	Overall	Binder	Flamingo	Gun/Knife	Overall
Combined	.48 [.42 - .55]	.49 [.42 - .56]	.34 [.29 - .38]	.44 [.40-.47]	.41 [.34 - .47]	.35 [.28 - .42]	.30 [.25 - .35]	.35 [.32-.39]	.44 [.40 - .49]	.42 [.37 - .47]	.32 [.29 - .35]	.39 [.37-.42]
Object Wielder	.55 [.41 - .70]	.41 [.26 - .57]	.41 [.31 - .51]	.46 [.38-.54]	.53 [.38 - .68]	.42 [.27 - .57]	.39 [.29 - .50]	.45 [.37-.53]	.54 [.44 - .65]	.42 [.31 - .52]	.40 [.33 - .47]	.45 [.40-.51]

Table 4 *Counts of Responses to Lineups as a Function of Threat, Duration, Complexity, and Target for Target-present Lineups*

	Correct IDs			Filler IDs			Incorrect Rejections*			*n*		
	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall
Object-Wielding Perpetrator												
Long Videos												
Nonthreatening	3	4	7	1	3	4	3	1	4	7	8	15
Threatening	7	4	11	1	3	4	1	2	3	9	9	18
Short Videos												
Nonthreatening	7	5	12	1	1	2	3	1	4	11	7	18
Threatening	4	0	4	7	4	11	5	2	7	16	6	22
All Video Durations												
Nonthreatening	10	9	19	2	4	6	6	2	8	18	15	33
Threatening	11	4	15	8	7	15	6	4	10	25	15	40
Accomplice												
Long Videos												
Nonthreatening	5	7	12	2	2	4	4	0	4	11	9	20
Threatening	6	5	11	3	3	6	2	0	2	11	8	19
Short Videos												
Nonthreatening	6	4	10	3	2	5	1	2	3	10	8	18
Threatening	3	3	6	3	1	4	4	3	7	10	7	17
All Video Durations												
Nonthreatening	11	11	22	5	4	9	5	2	7	21	17	38
Threatening	9	8	17	6	4	10	6	3	9	21	15	36
Both Perpetrators												
Long Videos												
Nonthreatening	8	11	19	3	5	8	7	1	8	18	17	35
Threatening	13	9	22	4	6	10	3	2	5	20	17	37
Short Videos												
Nonthreatening	13	9	22	4	3	7	4	3	7	21	15	36
Threatening	7	3	10	10	5	15	9	5	14	26	13	39
All Video Durations												
Nonthreatening	21	20	41	7	8	15	11	4	15	39	32	71
Threatening	20	12	32	14	11	25	12	7	19	46	30	76

*Not there and don't know responses were coded as rejections.

Table 5

Counts of Responses to Lineups as a Function of Threat, Duration, Complexity, and Target for Target-absent Lineups

	Filler IDs			Correct Rejections*			*n*		
	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall
				Object-wielding Perpetrator					
Long Videos									
Nonthreatening	4	3	7	7	6	13	11	9	20
Threatening	7	1	8	4	7	11	11	8	19
Short Videos									
Nonthreatening	4	5	9	6	3	9	10	8	18
Threatening	2	2	4	8	5	13	10	7	17
All Video Durations									
Nonthreatening	8	8	16	13	9	22	21	17	38
Threatening	9	3	12	12	12	24	21	15	36
				Accomplice					
Long Videos									
Nonthreatening	3	5	8	4	3	7	7	8	15
Threatening	6	7	13	3	2	5	9	9	18
Short Videos									
Nonthreatening	7	3	10	4	4	8	11	7	18
Threatening	14	4	18	2	2	4	16	6	22
All Video Durations									
Nonthreatening	10	8	18	8	7	15	18	15	33
Threatening	20	11	31	5	4	9	25	15	40
				Both Perpetrators					
Long Videos									
Nonthreatening	7	8	15	11	9	20	18	17	35
Threatening	13	8	21	7	9	16	20	17	37
Short Videos									
Nonthreatening	11	8	19	10	7	17	21	15	36
Threatening	16	6	22	10	7	17	26	13	39
All Video Durations									
Nonthreatening	18	16	34	21	16	37	39	32	71
Threatening	29	14	43	17	16	33	46	30	76

*Not there and don't know responses were coded as rejections.

Table 6 *Counts of Responses to Lineups as a Function of Unusualness, Duration, Complexity, and Target for Target-present Lineups*

	Correct IDs			Filler IDs			Incorrect Rejections*			*n*		
	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall
Object-Wielding Perpetrator												
Long Videos												
Usual	3	3	6	0	1	1	1	1	2	4	5	9
Unusual	7	5	12	2	5	7	3	2	5	12	12	24
Short Videos												
Usual	4	3	7	1	0	1	0	1	1	5	4	9
Unusual	7	2	9	7	5	12	8	2	10	22	9	31
All Video Durations												
Usual	7	6	13	1	1	2	1	2	3	9	9	18
Unusual	14	7	21	9	10	19	11	4	15	34	21	55
Accomplice												
Long Videos												
Usual	3	5	8	0	0	0	1	0	1	4	5	9
Unusual	8	7	15	5	5	10	5	0	5	18	12	30
Short Videos												
Usual	5	3	8	1	1	2	0	0	0	6	4	10
Unusual	4	4	8	5	2	7	5	5	10	14	11	25
All Video Durations												
Usual	8	8	16	1	1	2	1	0	1	10	9	19
Unusual	12	11	23	10	7	17	10	5	15	32	23	55
Both Perpetrators												
Long Videos												
Usual	6	8	14	0	1	1	2	1	3	8	10	18
Unusual	15	12	27	7	10	17	8	2	10	30	24	54
Short Videos												
Usual	9	6	15	2	1	3	0	1	1	11	8	19
Unusual	11	6	17	12	7	19	13	7	20	36	20	56
All Video Durations												
Usual	15	14	29	2	2	4	2	2	4	19	18	37
Unusual	26	18	44	19	17	36	21	9	30	66	44	110

*Not there and don't know responses were coded as rejections.

Table 7

Counts of Responses to Lineups as a Function of Unusualness, Duration, Complexity, and Target for Target-absent Lineups

	Filler IDs			Correct Rejections*			*n*		
	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall
				Object-wielding Perpetrator					
Long Videos									
Usual	1	1	2	3	4	7	4	5	9
Unusual	10	3	13	8	9	17	18	12	30
Short Videos									
Usual	2	3	5	4	1	5	6	4	10
Unusual	4	4	8	10	7	17	14	11	25
All Video Durations									
Usual	3	4	7	7	5	12	10	9	19
Unusual	14	7	21	18	16	34	32	23	55
				Accomplice					
Long Videos									
Usual	1	3	4	3	2	5	4	5	9
Unusual	8	9	17	4	3	7	12	12	24
Short Videos									
Usual	3	1	4	2	3	5	5	4	9
Unusual	18	6	24	4	3	7	22	9	31
All Video Durations									
Usual	4	4	8	5	5	10	9	9	18
Unusual	26	15	41	8	6	14	34	21	55
				Both Perpetrators					
Long Videos									
Usual	2	4	6	6	6	12	8	10	18
Unusual	18	12	30	12	12	24	30	24	54
Short Videos									
Usual	5	4	9	6	4	10	11	8	19
Unusual	22	10	32	14	10	24	36	20	56
All Video Durations									
Usual	7	8	15	12	10	22	19	18	37
Unusual	40	22	62	26	22	48	66	44	110

*Not there and don’t know responses were coded as rejections.

Table 8 *Counts of Responses to Lineups as a Function of Object, Duration, Complexity, and Target for Target-present Lineups*

	Correct IDs			Filler IDs			Incorrect Rejections*			*n*		
	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall
Object-Wielding Perpetrator												
Long Videos												
Binder	3	3	6	0	1	1	1	1	2	4	5	9
Flamingo	0	1	1	1	2	3	2	0	2	3	3	6
Gun/knife	7	4	11	1	3	4	1	2	3	9	9	18
Short Videos												
Binder	4	3	7	1	0	1	0	1	1	5	4	9
Flamingo	3	2	5	0	1	1	3	0	3	6	3	9
Gun/knife	4	0	4	7	4	11	5	2	7	16	6	22
All Video Durations												
Binder	7	6	13	1	1	2	1	2	3	9	9	18
Flamingo	3	3	6	1	3	4	5	0	5	9	6	15
Gun/knife	11	4	15	8	7	15	6	4	10	25	15	40
Accomplice												
Long Videos												
Binder	3	5	8	0	0	0	1	0	1	4	5	9
Flamingo	2	2	4	2	2	4	3	0	3	7	4	11
Gun/knife	6	5	11	3	3	6	2	0	2	11	8	19
Short Videos												
Binder	5	3	8	1	1	2	0	0	0	6	4	10
Flamingo	1	1	2	2	1	3	1	2	3	4	4	8
Gun/knife	3	3	6	3	1	4	4	3	7	10	7	17
All Video Durations												
Binder	8	8	16	1	1	2	1	0	1	10	9	19
Flamingo	3	3	6	4	3	7	4	2	6	11	8	19
Gun/knife	9	8	17	6	4	10	6	3	9	21	15	36
Both Perpetrators												
Long Videos												
Binder	6	8	14	0	1	1	2	1	3	8	10	18
Flamingo	2	3	5	3	4	7	5	0	5	10	7	17
Gun/knife	13	9	22	4	6	10	3	2	5	20	17	37
Short Videos												
Binder	9	6	15	2	1	3	0	1	1	11	8	19
Flamingo	4	3	7	2	2	4	4	2	6	10	7	17
Gun/knife	7	3	10	10	5	15	9	5	14	26	13	39
All Video Durations												
Binder	15	14	29	2	2	4	2	2	4	19	18	37
Flamingo	6	6	12	5	6	11	9	2	11	20	14	34

Gun/knife	20	12	32	14	11	25	12	7	19	46	30	76

*Not there and don't know responses were coded as rejections.

Table 9

Counts of Responses to Lineups as a Function of Object, Duration, Complexity, and Target for Target-absent Lineups

	Filler IDs			Correct Rejections*			*n*		
	Simple	Complex	Overall	Simple	Complex	Overall	Simple	Complex	Overall
					Object-wielding Perpetrator				
Long Videos									
Binder	1	1	2	3	4	7	4	5	9
Flamingo	3	2	5	4	2	6	7	4	11
Gun/knife	7	1	8	4	7	11	11	8	19
Short Videos									
Binder	2	3	5	4	1	5	6	4	10
Flamingo	2	2	4	2	2	4	4	4	8
Gun/knife	2	2	4	8	5	13	10	7	17
All Video Durations									
Binder	3	4	7	7	5	12	10	9	19
Flamingo	5	4	9	6	4	10	11	8	19
Gun/knife	9	3	12	12	12	24	21	15	36
					Accomplice				
Long Videos									
Binder	1	3	4	3	2	5	4	5	9
Flamingo	2	2	4	1	1	2	3	3	6
Gun/knife	6	7	13	3	2	5	9	9	18
Short Videos									
Binder	3	1	4	2	3	5	5	4	9
Flamingo	4	2	6	2	1	3	6	3	9
Gun/knife	14	4	18	2	2	4	16	6	22
All Video Durations									
Binder	4	4	8	5	5	10	9	9	18
Flamingo	6	4	10	3	2	5	9	6	15
Gun/knife	20	11	31	5	4	9	25	15	40
					Both Perpetrators				
Long Videos									
Binder	2	4	6	6	6	12	8	10	18
Flamingo	5	4	9	5	3	8	10	7	17
Gun/knife	13	8	21	7	9	16	20	17	37
Short Videos									
Binder	5	4	9	6	4	10	11	8	19
Flamingo	6	4	10	4	3	7	10	7	17
Gun/knife	16	6	22	10	7	17	26	13	39
All Video Durations									
Binder	7	8	15	12	10	22	19	18	37
Flamingo	11	8	19	9	6	15	20	14	34
Gun/knife	29	14	43	17	16	33	46	30	76

*Not there and don't know responses were coded as rejections.

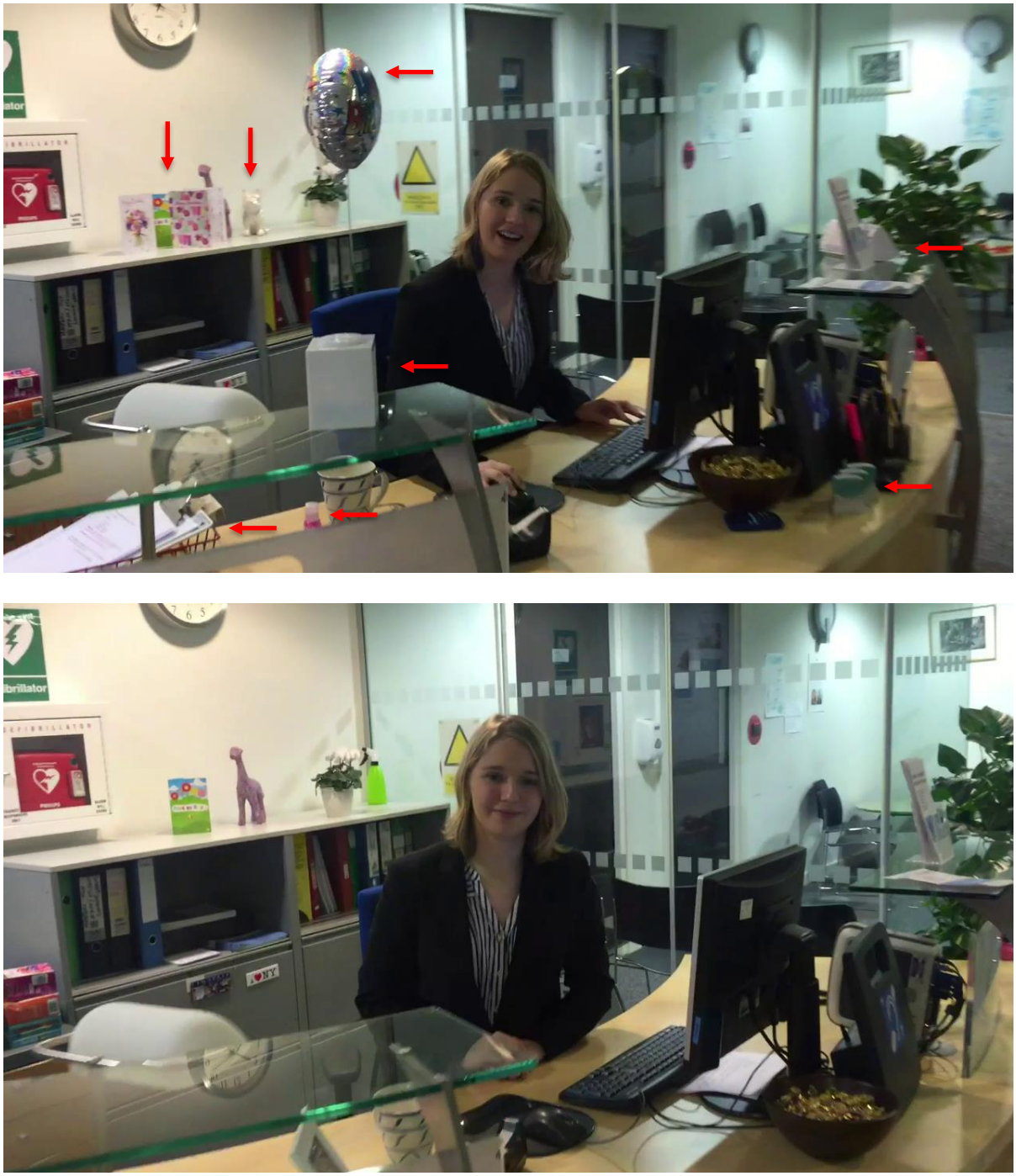

Figure 1. Screenshots illustrating the videos viewed in Experiment 2. Participants in the complex condition viewed a video exemplified by the upper panel while those in the simple condition viewed a video exemplified by the lower panel. Differences are highlighted with arrows in the upper panel, although not all differences are visible here.

Supplemental Analyses – Pilot Experiment

Manipulation Checks

Object Manipulation. The objects held by the actor were a gun (threatening and unusual), a knife (threatening but somewhat usual in a kitchen setting), a plastic lawn flamingo (nonthreatening and unusual) and a three-hole punch (nonthreatening and usual at a university). The classification of these objects was validated by a manipulation check wherein participants (N = 24) who did not participate in the main experiment were asked to rate the objects on how threatening and unusual they were both as independent objects and as objects in the context of the scene in which they were shown on a scale of 1 to 7 where 1 = *Not threatening/Usual* and 7 = *Highly threatening/Highly unusual*

We examined our manipulations by conducting separate repeated measures analyses of variance (RM ANOVAs) using a 2 Question type (object, object in scene) x 4 Object (gun, knife, flamingo, hole punch) model for questions about threat and questions about unusualness. Reported confidence intervals here and throughout the paper are 95% intervals. The most threatening object was the gun (M = 5.24 [4.55, 5.92]), followed by the knife (M = 4.48 [3.63, 5.32]; p = .01), and then the flamingo (M = 1.50 [1.09, 1.91]; p < .001) and the hole punch (M = 1.71 [1.27, 2.16]), which did not differ (p = .40). Neither the main effect of question type or the interaction of object and question type were significant (ps > .21). All objects were rated as significantly more unusual than the hole punch (M = 2.10 [1.56, 2.64]; p < .001), but the rest were rated as equally unusual (gun: M = 5.55 [4.85, 6.25]; knife: M = 5.08 [4.37, 5.78], flamingo: M = 5.62 [4.98, 6.27], ps > .14). Based on these results, for our data analyses we treated both the gun and knife as threatening and unusual; the flamingo as nonthreatening and unusual; and the hole punch as non-threatening and usual. Thus, we did not have a threatening, usual condition.

Question type and the interaction of object and question type were not significant (*p*s > .35).

Attention Check. Most participants correctly indicated which actor was holding the target object (.86). Naming of the object was more poorly done, particularly for the hole punch. We counted the number of participants who did not receive at least partial credit for naming the object held by one of the actors. For example, participants received partial credit for responses such as "holding a black tube" if the actor had been holding the hole punch. We were liberal in awarding partial credit as we simply wanted to ensure that the participant paid attention, not to ensure they remembered the object, necessarily. Of those who correctly answered the first question, the following numbers of participants failed to receive partial or full credit on the second manipulation check: 13 in the hole punch condition (n = 18 resulting), two in the flamingo condition (n = 32 resulting), three in the knife condition (n = 25 resulting), and seven in the gun condition (n = 20 resulting). Thus, a subsample of 95 participants adequately answered both manipulation check questions. We ran all analyses on the subsample and the full sample; however, the pattern of results differed little, therefore we report the results for the full sample and note where the results differed between subsample and the full sample.

Data Analyses

All memory questions. We first examined whether our variables of interest influenced performance on the set of 14 questions participants were asked about the video.

Threat. We first conducted a 2 Threatening x 2 Duration x 2 Complexity ANOVA on the proportion correct responses to our questions about the video. We found no effect of threat, $F(1, 134) = 2.26$, $p = .14$, $d = 0.12$, but found a main effect of duration, $F(1, 134) = 11.90$, $p = .001$, $d = 0.28$, and a main effect of complexity, $F(1, 134) = 19.30$, $p < .001$, $d = 0.36$. Participants were more accurate when they viewed long (M = .56 [.53, .59]) than

short videos (*M* = .48 [.45, .52]) and simple (*M* = .57 [.54, .60]) than complex (*M* = .47 [.44, .50]) videos.

These main effects were qualified by a significant three-way interaction of threat, duration, and complexity, $F(1, 134) = 5.63$, $p = .019$, $\eta_p^2 = .04$. To examine this interaction, we conducted separate two-way ANOVAs for the long video and short video conditions. When the video was short, we found a significant main effect of complexity $F(1, 68) = 18.17$, $p < .001$, $d = 0.50$, and a significant interaction of complexity and threat, $F(1, 68) = 4.27$, $p = .009$, $\eta_p^2 = .10$. Follow up analyses on the short condition showed there was a simple main effect of threat in the simple video condition, $F(1, 68) = 7.58$, $p = .008$, $d = 0.34$, but not the complex video condition ($p = .30$). When participants saw short, simple videos, they were more accurate if the actor had been holding a threatening (*M* = .61 [.55, .67]) than a non-threatening object (*M* = .49 [.43, .55]). For long videos, there was a significant effect of complexity only, $F(1, 66) = 4.14$, $p = .046$, $d = 0.25$ (all other *p*s > .30). For long videos, participants remembered more when they had seen a simple video (*M* = .60 [.55, .64]) than a complex video (*M* = .53 [.48, .58]). The simple effect of complexity when participants viewed long videos was not significant when we analyzed the subsample, however ($p = .17$).

Unusualness. We next conducted a 2 Unusualness x 2 Duration x 2 Complexity ANOVA on proportion correct responses to the questions about the video. There was a significant main effect of unusualness, $F(1, 134) = 5.81$, $p = .017$, $d = 0.31$. Participants remembered more when the target actor held an unusual (*M* = .54 [.51, .57]) compared to a usual object (*M* = .48 [.43, .52]). There was also a significant main effect of duration, $F(1, 134) = 9.28$, $p = .003$, $d = 0.25$, whereby participants remembered more about long (*M* = .55 [.51 .58]) than short videos (*M* = .47 [.43 .51]), although this effect did not reach significance in our subsample analysis ($p = .21$). Finally, we found a significant main

effect of complexity, $F(1, 134) = 15.33$, $p < .001$, $d = 0.33$, wherein participants remembered more from simple ($M = .56$ [.52 .60]) than complex videos ($M = .46$ [.42, .50]). There were no significant interactions (ps > .26).

Threat versus unusualness. Our next analysis was aimed at understanding the relative contributions of threat and unusualness to memory for an event. For this analysis we conducted a 3 Object x 2 Duration x 2 Complexity ANOVA on proportion correct responses to the questions about the video. Our pilot tests indicated we had two threatening and unusual objects (gun and knife), a nonthreatening and unusual object (flamingo), and a nonthreatening and usual object (hole punch). Thus, this analysis allows us to test the extent to which threat plays a role above and beyond the role of unusualness.[8] The analysis elicited main effects of duration $F(1, 130) = 6.75$, $p = .010$, $d = 0.21$, and of complexity $F(1, 130) = 15.17$, $p < .001$, $d = 0.32$, as described above, but a nonsignficant effect of object, $F(2, 130) = 2.30$, $p = .104$, $\eta_p^2 = .03$. Planned pairwise comparisons between our three categories of objects indicated that the gun and knife condition ($M = .54$ [.51, .58]) resulted in similar memory for the scene as the flamingo condition ($M = .53$ [.48, .58]; $p = .18$) but better memory than the hole punch ($M = .48$ [.44, .53]; $p = .034$); the flamingo and the hole punch conditions did not differ ($p = .60$) None of the interactions approached significance (ps > .16).

Questions about the object-wielding actor. Following Carlson et al. (2016) we examined our variables of interest for questions specific to the actor holding the object as these three questions should be most sensitive to the WFE.

Threat. A 2 Threat x 2 Duration x 2 Complexity ANOVA produced a main effect of duration, $F(1, 134) = 10.02$, $p = .002$, $d = 0.26$, and a marginal main effect of complexity,

[8] Conducting this analysis with Object as a four-level variable yielded the same results as collapsing across gun and knife.

$F(1, 134) = 3.81$, $p = .053$, $d = 0.16$, but no other significant effects or interactions (ps > .19). The direction of these effects was the same as for those reported above.

Unusualness. A 2 Unusualness x 2 Duration x 2 Complexity ANOVA on memory for the object-wielding actor produced a main effect of duration, $F(1, 134) = 10.24$, $p = .002$, $d = 0.36$, and a main effect of complexity, $F(1, 134) = 5.23$, $p = .024$, $d = 0.19$. The direction of these effects mirrored those reported above. In addition, this analysis elicited a significant three-way interaction of duration, complexity, and unusualness, $F(1, 134) = 6.41$, $p = .013$, $\eta_p^2 = .05$ (all other ps $\geq .13$). Follow up analyses indicated no significant effect of complexity, unusualness, or their interaction on memory for the actor wielding the object when the video was short (ps > .21). When the video was long, the effect of complexity was significant, $F(1, 66) = 4.99$, $p = .029$, $d = 0.27$, and there was a significant interaction of complexity and unusualness, $F(1, 66) = 9.58$, $p = .003$, $\eta_p^2 = .13$. Simple effects analysis showed that memory for the actor was higher when he held an unusual (M = .85 [.75, .95]) than a usual object (M = .61 [.47, .75]) in the complex video ($p = .007$) but usualness made no difference in the simple video condition ($p = .12$).

Threat versus unusualness. Finally, we conducted a 3 Object x 2 Duration x 2 Complexity on memory for the actor holding the focal object. This analysis produced a significant main effect of duration, $F(1, 130) = 7.30$, $p = .008$, $d = 0.22$, with means following the pattern described in our overall memory analysis. We also found a marginally significant main effect of complexity, $F(1, 130) = 3.03$, $p = .084$, $d = 0.14$, again following the pattern described above. There were no other significant effects (all ps > .18).

Lineups. We conducted logistic regressions to examine whether unusualness, duration, complexity, and their interactions predicted the accuracy of lineup decisions. In a first step we entered the main effects, followed by stepwise forward entry (using a

likelihood ratio model approach) of the interactions in a second step. The effect of threat was not examined because it was confounded with target presence. We analyzed target-present and target-absent lineups separately for each actor.

For target-present lineups for the actor holding the focal object, the final model was not significant, $\chi 2(3) = 5.11$, $p = .16$, $r_{Nagelkerke}^2 = .06$, and none of the individual main effects were significant either (*p*s > .11). For target-present lineups for the actor not holding anything, the final model was not significant, $\chi 2(3) = 3.79$, $p = .28$, $r_{Nagelkerke}^2 = .08$. However, unusualness was a significant predictor within the model, $B = -1.17$, $\chi 2(3) = 3.79$, $p = .28$, $OR = 0.31$, such that the actor not holding anything was 3.22 times more likely to be correctly identified when the object was usual (.47) than unusual (.22). No other main effect predictors were significant (*p*s > .77).

For target-absent lineups for the actor holding the focal object, the final model was not significant, $\chi 2(3) = 5.12$, $p = .16$, $r_{Nagelkerke}^2 = .16$, with no significant predictors (*p*s > .35). The final model for target-absent lineups for the actor not holding anything was also not significant, $\chi 2(3) = 0.89$, $p = .83$, $r_{Nagelkerke}^2 = .02$, and contained no significant main effects (*p*s > .50).

Supplemental Analyses – Target-present Lineup Rejections

Threat

Object-wielding Perpetrator. For target-present lineup rejections, the final model for the object-wielding perpetrator was not significant, $\chi2(4) = 4.92$, $p = .30$, $r_{Nagelkerke}^2 = .10$. However, the interaction of complexity and duration was a significant predictor, $B = 2.40$, $\chi2(1) = 4.09$, $p = .043$, $OR = 11.03$. Given that this interaction did not include threat; however, we did not explore it further.

Accomplice. The target-present lineup rejections for the accomplice were difficult to make sense of. The main effects only model conducted as the first step of the regression was marginally significant, $\chi2(3) = 6.83$, $p = .078$, $r_{Nagelkerke}^2 = .14$, with only complexity accounting for significant variance, $B = 1.26$, $\chi2(1) = 4.10$, $p = 0.43$, $OR = 3.52$ (all other main effect ps > .12). Participants were significantly more likely to reject a target-present lineup when the scene was complex (.31) compared to simple (.13). The stepwise regression continued to a second step; however, a final solution could not be found. We re-ran the stepwise regression without the three-way interaction and this time the final model included only the main effects.

Unusualness

Object-wielding Perpetrator. The regression to predict rejections of target-present lineups for the object-wielding perpetrator failed to converge. We alternatively ran the same model with only the main effects and two-way interactions. This model ran but was not significant, $\chi2(4) = 5.24$, $p = .26$, $r_{Nagelkerke}^2 = .10$. The model did not account for significant variance at the first step (main effects), $\chi2(3) = 1.12$, $p = .77$, $r_{Nagelkerke}^2 = .02$ (main effect ps > .45) but did account for significant variance in the second step (two-way interactions) $\chi2(3) = 4.11$, $p = .043$, $r_{Nagelkerke}^2 = .08$. The interaction of complexity and

duration was significant, $B = 2.34$, $\chi2(1) = 3.84$, $p = .050$, $OR = 10.35$ (main effect ps > .08). As this interaction did not include unusualness, we did not explore it further.

Accomplice. For the accomplice, the final model for target-present lineup rejections was significant, $\chi2(4) = 20.14$, $p < .001$, $r_{Nagelkerke}^2 = .37$. In the first step, $\chi2(3) = 12.11$, $p = .007$, $r_{Nagelkerke}^2 = .23$, we found a main effect of complexity, $B = 1.34$, $\chi2(1) = 4.33$, $p = .037$, $OR = 3.83$, as described in our threat analysis above. The main effects of duration, $B = -1.08$, $\chi2(1) = 2.92$, $p = .087$, $OR = 0.39$, and unusualness, $B = 2.11$ $\chi2(1) = 3.68$, $p = .055$, $OR = 8.27$, were marginally significant. Participants made more lineup rejections when the video was short (.29) than long (.15) and when the video depicted an unusual object (.27) than a usual object (.05). The final model incorporated the main effects as well as the three-way interaction of duration, complexity, and unusualness. As such, an alternative model was run incorporating also the relevant two-way interactions; however, this model failed to converge. We next ran a regression where we entered the main effects and then allowed forward stepwise entry of only the two-way interactions. This regression also failed to find a final solution; therefore it appears that the main effects only model is the best fitting model.

Threat Versus Unusualness

Object-wielding Perpetrator. The final model for the object-wielding perpetrator was not significant, $\chi2(4) = 6.29$, $p = .18$, $r_{Nagelkerke}^2 = .12$. Although entering the main effects did not explain significant variance, $\chi2(3) = 0.67$, $p = .88$, $r_{Nagelkerke}^2 = .01$ (all main effect ps $\geq .70$), the second step in the model was significant, $\chi2(1) = 5.62$, $p = .018$, $r_{Nagelkerke}^2 = .12$. In the second step, there was a significant three-way interaction of complexity, duration, and object; however, a follow up regression in which we entered the relevant two-way interactions failed to converge.

Accomplice. The final model for target-present lineup rejections for the accomplice was significant, $\chi 2(4) = 16.79$, $p = .002$, $r_{Nagelkerke}^2 = .31$. There was a main effect of complexity (as described in the analysis for threat above), $B = 2.87$, $\chi 2(1) = 8.58$, $p = .034$, $OR = 17.68$, and a main effect of object, $B = 0.95$, $\chi 2(1) = 4.47$, $p = .034$, $OR = 2.59$ ($p = .35$ for the main effect of duration).There was also a significant three-way interaction of complexity, duration, and object. Thus, we followed up with a regression in which we included the two-way interactions as well as the main effects and the three-way interactions. This model was significant, $\chi 2(7) = 18.81$, $p = .009$, $r_{Nagelkerke}^2 = .35$; however, none of the individual predictors in the model reached significance (all ps > .11).

Supplemental Table 1

Responses to Lineups as a Function of Target and Target Presence

	Response to Lineup							
	1	2	3	4	5	6	Not There	Don't Know
Actor	Target-present lineups							
Actor holding object	3	**34**	8	5	4	1	13	5
Actor without object	3	4	2	4	**42**	7	9	6
	Target-absent lineups							
Actor holding object	5	4	5	2	9	4	37	8
Actor without object	11	9	9	6	6	8	20	4

Note: For target-present lineups, the location of the target is bolded.

Supplemental Figure 1. Screen shot of one of the videos shown to participants in the pilot experiment. Participants in the complex condition viewed the full scene while participants in the complex scene viewed the video cropped to the dimensions of the black box.

Supplemental Table 2

Cued Recall Questions About the Mock Crime Video

Question	Correct (1.0)	Partially Correct (0.5)
All Participants		
What colour was the perpetrator with the weapons' jacket? [perpjacket]	green, dark green	khaki, dark
What colour were the flowers on the small plant behind the receptionist? [flowercolour	white, cream, eggshell	pale, light
What colour was the chair you sat in? [colourchair]	purple, violet	blue, light blue
What colour was the clock on the wall (not the face)? [colourclock]	silver, grey, chrome	shiny
What was above the door that the perpetrators ran out? [abovedoor]	fire exit Sign, fire exit	sign, exit sign, fire safety poster
What colour was the mug on the cabinet behind the receptionist? [colourmug]	red	dark orange, orange
How many birthday cards were behind the bank teller? [birthdaycard]	4	3, 5
What colour was the bin lid? [binlidcolour]	red	dark orange, orange
How many posters were on the wall? [posterswall]	3	2, 4
Complex Condition Only		
What was on top of the radiator behind the receptionist? [ontopradiator]	umbrella, brolly	cane
What was in front of the reception desk to the left? [frontdesk]	large plant, plant, plant pot, potted plant	flowers, pink toy {this was sitting on top of the plant}
What was on the floor below the bulletin board of where you were sitting? [frontbullitin]	fire extinguisher	fire hydrant
What was floating to the right of the receptionist? [floating]	balloon, happy birthday balloon, helium balloon	-
What colour was the spray bottle behind the receptionist next to the plant? [whatcabinet]	green, lime	yellow, yellowish
What colour was the lamp shade on the reception desk? [lampshade]	white, cream, eggshell	pale, light

Supplemental Table 3

Recognition Questions About the Mock Crime Video

Question	Response Options
All Participants	
What mobility aid was to the right of the receptionist? [mobility]	a) Crutches b) Walking Stick c) Mobility Scooter d) Wheelchair*
What was the bank teller's hair like? [tellerhair]	a) Short Blonde* b) Long Blonde c) Short Brunette d) Long Brunette
What kind of trousers was the perpetrator with the weapon wearing? [trousersweapon]	a) Jeans* b) Plain Black c) Chinos d) Leather
What did the leaflet say? [leafletsay]	a) Open a savings account today b) Open a student account today* c) Start a mortgage d) Welcome to HBG banking
Which item was above the cabinet behind the bank teller? [abovecounter]	a) ATM machine b) Wall light c) Defibrillator* d) Poster
What was next to the leaflets on the bank teller's counter? [leftleaflet]	a) Card machine b) Bowl of Sweets c) Small calendar* d) Pen
What did the bank teller say to you? [banktellersay]	a) Welcome to the bank b) Please can I have your deposit slip c) Please take a seat* d) Thank you for banking with HBG
What colour was the perpetrators jacket who did not have a weapon? [jacketcolour]	a) Blue b) Red c) Black* d) No jacket
Complex Condition Only	
What was sitting on the floor to your left [leftfloor]	a) Small Chair* b) Table c) Foot stool d) Magazine Rack
What animals were on top of the cabinet behind the bank teller? [animals]	a) Dog and Cat b) Pig and Dog c) Pig and Giraffe d) Giraffe and Dog*
What colour was the perpetrators jacket who did not have a weapon? [colourjacket]	a) Blue b) Red c) Black* d) Green
What colour was the calculator on the bank tellers desk? [calculatorcolour]	a) Pink * b) Blue c) Orange d) Black

Note: correct response is denoted with a star.